PATENT ABSTRACTS OF JAPAN

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(71)Applicant : JDS FITEL INC
(72)Inventor : CHENG YIHAO

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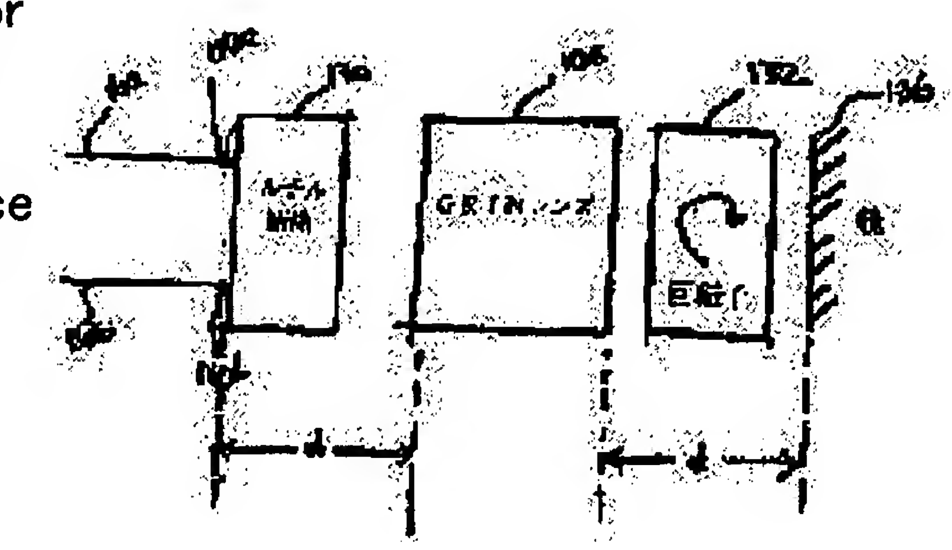
(54) OPTICAL ATTENUATOR

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an optical attenuator small small is size, easy to produce and low in cost.
SOLUTION: Optical fibers 16a and 16b of an optical waveguide are connected to an input port 110a and an output port 110b of one end face of a double- refracting crystal 130. A GRIN lens 105 and a polarizing rotor 132 are arranged between the double-refracting crystal 130 and a mirror 136. An optical distance (d) between the input/output end on the side of ports 110a and 110b of the double-refracting crystal 130 and the end face of the GRIN lens 105 nearest to this input/output end is equalized to the optical distance between the mirror 136 and the end face of the GRIN lens 105 nearest to this mirror 136.



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CLAIMS

[Claim(s)]
[Claim 1] The optical attenuator characterized by providing the following. It is the refraction element substantially refracted toward the output waveguide of opposite direction in the light which it has an input optical waveguide and an output optical waveguide, the edge of this input optical waveguide and an output optical waveguide was optically arranged so that a part of light [at least] of the input beam on which it was projected by the input waveguide might be turned to an output waveguide, and it was projected by the input waveguide and carried out incidence to it. The birefringence crystal which is arranged between a refraction element, an input, and an output waveguide, and divides an input beam into the first beam of the first polarization, and the second beam of the second rectangular cross polarization. The controllable polarization rotator which rotates polarization of the passing light alternatively. The lens means arranged between an optical waveguide and a refraction means.
[Claim 2] A refraction element is an optical attenuator according to claim 1 which is permeability partially and is characterized by including the detector which detects the light transmitted through the refraction element near the refractor.
[Claim 3] A lens means is an optical attenuator according to claim 1 characterized by being arranged between a birefringence crystal and a polarization rotator in order to draw non-collimation light through a birefringence crystal and to connect the focus of light to the end face of a reflective element.
[Claim 4] An input and an output waveguide are an optical attenuator according to claim 1 characterized by being in the same edge of an attenuator.
[Claim 5] It is the optical attenuator according to claim 1 characterized by for an input and an output waveguide being optical fibers, and arranging the lens means between a reflective element and a birefringence crystal in order to receive the non-**** rectangular cross polarization light beam from the input optical waveguide spread through a birefringence crystal.
[Claim 6] Have the following and the I/O optical waveguide is close to a lens in light at the lens which receives light from projection or a lens. The optical waveguide which has an edge, respectively is separated from the shortest edge of a lens by the optical path of abbreviation d1. d1> The end face of the lens which **** substantially as 0, and the optical path between refractors are an optical attenuator which is d1 and is characterized by being arranged between a birefringence crystal and a refractor in order to rotate polarization of the light which a polarization rotator passes. Input optical waveguide. Output optical waveguide. A lens with a substantial collimation end face and a focal end face. The refractor which turns to an output waveguide the birefringence crystal which it is combined with a lens, and separates a rectangular polarization light beam and is combined, and the incident beam on which it was projected by the input waveguide.
[Claim 7] branching means **** which branches and detects the portion of the light revealed through the reflector -- the optical attenuator according to claim 6 characterized by things
[Claim 8] The optical attenuator according to claim 1 characterized by passing a birefringence crystal before the light on which it was projected by the input waveguide passes a lens.
[Claim 9] Have the following and input/output port is close to a lens in light at the lens which receives light from projection or a lens. The port is separated from the shortest edge of a lens by the optical path of abbreviation d1. The collimation end face of a substantial lens and the optical path between refractors are an optical attenuator which is d1 as d1>0 and is characterized by arranging the polarization rotator in order to rotate polarization of the light which passes through that between a birefringence crystal and a reflecting surface. The input port and the output port in the first edge of equipment. A lens with a substantial collimation end face and a focal end face. The birefringence crystal combined with the lens in order to approach an input and an output port in order to receive the light which does not carry out the collimation from input port, to be arranged, to separate a rectangular polarization light beam and to join

together. The refractor which turns to an output port the incident beam on which it was projected by the input waveguide.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the optical attenuator decreased possible [control of a lightwave signal].
[0002]
Background of the Invention] Many optical attenuators are known for the field of optical technology. Although the polarization beam splitter known for the technology concerned is used for these existing things, they have the fault, respectively. Furthermore, the attenuator using the beam splitter which divides an incident beam into two polarization beams needs the beam splitter of the same piece for the real target which combines the beam splitter of the piece which divides an incident beam into two polarization beams which intersect perpendicularly, and the beam which polarized with a single light beam. Efforts are required to offer the adjustment crystal of a couple, and cost increases.
[0003] It operates by being cut in the shape of prism, and the Glan-Thompson polariscope (polarizer) which is the block of the birefringence material pasted up together reflecting one polarization component in an adhesion interface, and penetrating another side. Since this equipment generally needs most amount of birefringence material like a short and expensive calcite and light breaks or clouds adhesives, it can operate neither by high power laser nor ultraviolet rays. Furthermore, this beam splitter using a reflective polarization component has the fault of addition that a polarization beam leaves equipment at an angle with 45-degree bad convenience when it is often useful that a beam is parallel, a rectangular cross, or other angles.
[0004] Although the Glan-Taylor polariscope (polarizer) which uses air space instead of adhesives in order to separate a polarization component although it is the same as that of a Glan-Thompson polariscope operates with many light sources, it receives the reflection loss and ghost who arise by the air gap.
[0005] Although Wollaston and Rochon which separate a polarization component by making a component penetrate through an interface, and a Senarmont beam splitter permit the optical contact to almost all the light sources on the occasion of use, the polarization component of one side or both makes the beam left at an inconvenient angle in response to coloring and distortion.
[0006] A double refraction element (beam displacer) makes an parallel polarization light beam, and attains small beam separation and the limited field. Moreover, since a beam may pass most quantity of material before attaining useful separation, the wave front distortion by the imperfection under crystal composition arises in an unusual beam (for example, refer to 710 -712 pages in 49 "birefringence of crystal and calcite" U.S. Kunimitsu society magazines, No. 7, and July, 1959). Beam separation is restricted by the small size and the small expensive rank of a still more suitable crystal. It is the purpose of this invention to use a beam substitution crystal and to solve some of these limits in view of those situations.
[0007] A polarizing prism and its various defects are Bennett. and The "polarization" light handbook written by Bennett, Driscoll It is described in detail in the volume on Vaughan, McGraw-Hill, and 1978.
[0008] U.S. patent No.5,727,109"E-tek Dynamics" as bibliography is indicating two lenses to which polarization of the light beam which passes through there is changed, two crystals, and the optical attenuator with the liquid crystal cell of a piece here. Although this equipment performs the meant function, this design has some faults. For example, since it is adapted for the **** beam given with a **** lens, it needs to have two optical crystals thick enough. Since it must be large in order it is [these crystals] adapted and to divide them into a **** beam, those costs are very serious. Furthermore, this equipment needs the crystal of a couple and it increases the cost of equipment further. Furthermore, since attention must be paid so that the fully adjusted crystal may be offered again, this also pushes up the manufacturing cost of this equipment. Another fault of this design may be the size, and its larger thing may be desirable.

[0009]
[Problem(s) to be Solved by the Invention] It is in offering a comparatively cheap optical attenuator small by this invention avoiding most above-mentioned faults or all. That is, this invention is a polarization beam splitter which avoids most above-mentioned faults of advanced-technology equipment, and is not complicated, and it is the purpose of this invention to offer a cheap optical attenuator by manufacturing. Moreover, it is still more nearly another purpose to offer the equipment in which a manufacturing cost has a far low birefringence crystal as the core element rather than birefringence crystal conformity equipment available in a commercial scene. Furthermore, it is still more nearly another purpose of this invention to offer the polarization beam splitter using the same form as a beam shift crystal of the optical attenuator which needs a far small crystal rather than equipment conventionally available in a commercial scene. It is the purpose of this invention to offer the optical attenuator which needs only single division/joint light element which divides the light beam on which it was projected into two polarization beams which intersect perpendicularly substantially further again, and combines these beams with a single beam. Furthermore, it is still more nearly another purpose of this invention to offer an optical attenuator with reflective clinch composition.
[0010]
[Means for Solving the Problem] According to this invention, the optical attenuator which has the following composition is offered. Namely, have an input optical waveguide and an output optical waveguide, and the edge of this input optical waveguide and an output optical waveguide is optically arranged so that a part of light [at least] of the input beam on which it was projected by the input waveguide may be turned to an output waveguide. Moreover, the refraction element substantially refracted toward the output waveguide of opposite direction in the light which it was projected by the input waveguide and carried out incidence to it, It is arranged between a refraction element, an input, and an output waveguide, and has the birefringence crystal which divides an input beam into the first beam of the first polarization, and the second beam of the second rectangular cross polarization, the controllable polarization rotator which rotates polarization of the passing light alternatively, and an optical waveguide and the lens means arranged between refraction meanses.
[0011] Moreover, according to this invention, the optical attenuator which has the following composition is offered. Namely, an input optical waveguide, an output optical waveguide, and a lens with a substantial **** end face and a focal end face, The birefringence crystal which it is combined with a lens, and separates a rectangular polarization light beam and is combined, It has the refractor which turns to an output waveguide the incident beam on which it was projected by the input waveguide. The I/O optical waveguide is close to the lens which receives light from projection or the lens in light at the lens. The optical waveguide which has an edge, respectively is separated from the shortest edge of a lens by the optical path of abbreviation d1. d1> The end face of the lens which **** substantially as 0, and the optical path between refractors are d1, and in order to rotate polarization of the light which a polarization rotator passes, they are arranged between the birefringence crystal and the refractor.
[0012] According to this invention, the optical attenuator which has the following composition is offered further again. Namely, the input port and the output port in the first edge of equipment, and a lens with a substantial **** end face and a focal end face, The birefringence crystal combined with the lens in order to approach an input and an output port in order to receive the light which does not **** from input port, to be arranged, to separate a rectangular polarization light beam and to join together, It has the refractor which turns to an output port the incident beam on which it was projected by the input waveguide. Input/output port is close to the lens which receives light from projection or the lens in light at the lens. The port is separated from the shortest edge of a lens by the optical path of abbreviation d1, the **** end face of a substantial lens and the optical path between refractors are d1 as d1>0, and the polarization rotator is arranged in order to rotate polarization of the light which passes through that between a birefringence crystal and a reflecting surface.
[0013] The composition of the same advantageous design for which this invention uses a birefringence beam move crystal especially which needs a small (about 1/50 of sizes) birefringence crystal substantially rather than it is most commercially required of the equipment which can be used is offered.
[0014]
[Embodiments of the Invention] Hereafter, the example of an operation form of this invention is explained based on a drawing. In addition, on account of explanation, for contrast of each example of an operation form, the advanced technology is woven in suitably and explained.
[0015] Drawing 9 shows well-known polarization beam splitter / coupler design. In this drawing, a birefringence crystal 10 like a calcite crystal is arranged, and three 1 pitch focus / **** gray dead index lenses for 4 minutes of 12c placed in order to receive the light from other two lenses to the first end face at the end face of the opposite side of a crystal of 12a and 12b (GRIN lens) are arranged.
[0016] In drawing 9 , the beam width 14a and 14b of the end side of the lens of a piece shown by the thick line in a

lens-crystal-grain-boundary side specifies length smaller than the minimum size of a crystal end face. A size is decided that the size of a crystal end face is adapted for a beam including the alignment clearance of some additions shown by length d2. If it puts in another way, since the GRIN lenses 12a and 12b have a diameter d1, respectively and some adjustment/conformity intervals d2 are between lens 12a and 12b, a crystal must have sufficient width of face to be adapted for the sum total of length (crosswise length) S=d1+d1+d2. Furthermore, since crosswise length S increases for the special design condition to which d1 or d2 is made to increase, the overall length lc of a crystal must also increase.

[0017] Conversely, if a crystal is shortened by the half of the length shown in drawing 9 , the interval which can be used in order to place Lenses 12a and 12b will decrease. This is shown in drawing 10 , and crystal length is set to lc/2, and it becomes an invalid example without sufficient interval which places Lenses 12a and 12b here, and a lens overlaps (overlap) and is shown by the drawing. Therefore, the requirement which uses the lens which carries out the collimation of the light spread through a crystal 10 produces the restrictions which use the crystal with which the size was decided to be adapted for at least two lenses or a collimation light beam.

[0018] The example of an operation gestalt by one side of this invention is shown in drawing 1 , and according to this, it is shown that the polarization beam splitter / coupler of an optical attenuator have two waveguides in the form of the optical fibers 16a and 16b directly connected with the end side of the small birefringence crystal 30 using the fiber pipe which is not illustrated. The size of the crystal 30 demanded in the example of an operation gestalt of drawing 1 should especially note being about 1 of size of crystal 10 demanded by conventional beam splitter shown in drawing 9 /50. Therefore, there is little cost reduction which manufactures the equipment of drawing 1 farther than the equipment shown in drawing 9 . Furthermore, in this first example of an operation gestalt of this invention, the lens of a piece is merely needed as compared with three lenses needed with the advanced-technology equipment shown in drawing 9 .

[0019] In drawing 1 , from the end face of a crystal 30, the output optical waveguide of optical fiber form is isolated, and is placed. A lens 32 is placed between optical fiber 16c and a crystal 30, in order to combine the light between optical fiber 16a and 16c and between optical fiber 16b and 16c.

[0020] In this example of an operation gestalt, since optical fibers 16a and 16b can approach very much mutually, the size of a crystal 30 is made very small and, as a result, serves as remarkable cost reduction. Furthermore, if the length of a crystal carries out even those with short ****** very much, it will become an execute permission to spread the beam from Fibers 16a and 16b as a non-collimation beam through a crystal 30 and to combine these beams with optical fiber 16c via a lens 32. It is clear that the diameter of the beam spread through a crystal increases here as crystal length increases.

[0021] On the occasion of operation (beam operation), the equipment shown in drawing 1 operates as follows. As a beam splitter, it is projected on a strange polarization light by optical fiber 16c which functions as input port. It is divided into two beams when a beam passes through a crystal 30. o-beam-of-light polarization beam is drawn by crystal port 16a, and e-beam-of-light polarization light is led to port 16b. On the contrary, combination is similarly performed by opposite direction. Since there is no lens between Fibers 16a and 16b and a crystal 30, the light which passes through the short length of a crystal is in a non-**** state.

[0022] With the optical equipment of present many, in order to combine light more efficiently, the collimation of the diffused-light beam to which the lens of various kinds of form comes out of an optical waveguide is carried out, and it is used so that the focus of the light on which it was projected by the optical waveguide may be connected.

[0023] One of the reasonable universal assembly blocks used for a design and manufacture of an optical element is a gray dead index (GRIN) lens. This kind of lens is produced under the tradename of "SELFOC." This mark is registered as a trademark in Japan and Japan sheet glass incorporated company owns it. A GRIN lens is used for manufacture of WDM equipment, an optical coupling machine, a circulatory organ (circulator), an isolator, and other equipments in combination with other optical elements. Although use of the GRIN lens in this invention offers many advantages to other conventional lenses, it does not limit this invention only to a GRIN lens.

[0024] The advantage of a GRIN lens is comparatively cheap and compact, and is having the parallel flat end face further. The light reflected from the end face of a lens can be similarly used especially for the flat end face of a GRIN lens as a means to branch, as a means to tie a single lens for the collimation of light, and a focus.

[0025] Next, reference of drawing 11 shows the quarter pitch GRIN lens substantially with tracing of three beams on which it was projected from three positions near the end face of a lens 42, and 41c, 41b and 41a. The beam on which it was projected from position 41c is expanded, and going into a lens for a latus diameter rather than other two beams on which it was projected from positions 41b and 41a is shown. When this is projected on light at the opposite edge of a lens as a collimation beam again, it is illustrating depending for the focal position of a beam on a beam diameter.

[0026] In order to combine light efficiently through a lens like a GRIN lens, it is desirable to project a beam with a narrow (small) diameter on a lens. For this reason, in drawing 1 , it goes into a lens 32, and when the beam spread

toward 16c from optical fiber 16a and/or 16b has a latus (large) diameter extremely, some of light which entered around the lens is not efficiently combined with the light-receiving edge of optical fiber 16c.
[0027] The beam spread toward 16c from optical fiber 16a has a comparatively small diameter, and drawing 3 illustrates the example of an alternative implementation gestalt of this invention whose diameter of the beam included in a lens 42 is the abbreviation half of the beam diameter included in the lens 42 in the arrangement shown in drawing 2 or drawing 1 .
[0028] Reference of (a) of drawing 12 shows the quarter pitch GRIN lenses 110a and 110b of a couple which have a collimation end face inside and have a focal end face outside. Two waveguides 111a and 111b which are a lens and the same axle and were combined with the lens along with the optical axis of the lenses 110a and 110b shown by the dotted line are shown. The beam profile is shown in the interior of lens 110a and 110b as if it was projected on light by each lens from one of the waveguides 111a and 111b. The beam profile in the interface between two lenses is elongated to the periphery of the lens shown with the points 112a and 112b which are two on a periphery.
[0029] Although (b) of drawing 12 illustrates a pair of same GRIN lens as (a) of drawing 12 , from the common optical axis of Lenses 110a and 110b, two optical waveguides 111a and 111b offset only the same optical path, and are shown. Here, although the beam profile in the interface between two lenses is elongated to the same periphery as (a) of drawing 12 , the angle of a beam is changing. When a waveguide is parallel to the common optical axis shared with a lens by ensuring that between two lenses has not dissociated, and that an optical waveguide couples directly with each lens, light is combined to 111b of another side most effectively (to or the reverse) from one waveguide 111a. The same arrangement is shown in (c) of drawing 12 , and input/output waveguides 111a and 111b are arranged to the thing of (b) of drawing 12 here at the opposite side of the optical axis of a lens.
[0030] If drawing 13 is referred to, the lens shown in (c) of drawing 12 carries out fixed distance isolation here, and is placed. The optical axis of waveguide 111a is shown in parallel with the optical axis OA of lens 110a. However, in order to combine the light in output waveguide 111b efficiently, output waveguide 111b must not be parallel to input waveguide 111a, and must be an angle theta about the optical axis of lens 110b depending on the amount (interval of a lens) of separation. Essentially, the output beam is diffused from the optical axis of lens 110b as the separation between two lenses (separation interval) increases.
[0031] In drawing 14 , although the lenses 110a and 110b which do not have a gap between lenses are shown, an input and the output waveguides 111a and 111b are separated from the end face of the lens with which they are combined optically. As a result of this gap, the light combined with optical fiber 111b serves as an angle theta, and does not combine light with a waveguide efficiently.
[0032] according to one side of this invention, it is shown in drawing 4 -- as -- a ratio predetermined in the interval of an input waveguide, and the interval between contiguity lenses -- light is substantially combined with one optical axis of Lenses 110a and 110b efficiently from an parallel input waveguide by ensuring that it is less than to an output waveguide In the detail, it is more separated [from the lenses 110a and 110b shown in drawing 4] of the optical path l3. The input waveguides 111a and 111c are in an optical path l1 from the end face of lens 110a. The output waveguides 111b and 111d are in an optical path l2 from those contiguity lens 110b.
[0033] In order for the optimal connection to exist and for an input and an output optical waveguide to use those opticals axis as the optical axis of the lens on the same shaft at parallel, the relation of l1=l2=0.5l.3 must exist mostly.
[0034] Again, reference of drawing 3 shows the two same birefringence crystals 50a and 50b whose each is the halves of the length of a crystal 30. Between crystal 50a and 50b, its distance is kept from those end faces, and two substantial focal lenses which have a focal position in the center between lenses 42 are placed. Waveguides 16a and 16b are connected with one edge of crystal 50a, and waveguide 16c is connected with crystal 50b.
[0035] If it is in operation (beam operation), o-beam-of-light inclination light on which it is projected by port 16a crosses equipment like previous instantiation, and is turned to port 16c, and e-beam-of-light inclination light on which it is projected by port 16b is turned to port 16c in order to combine with o-beam-of-light inclination light.
[0036] However, since a crystal 42 (crystal 50a) is shorter than a crystal 30, the beam (beam diameter) included in the lens 42 near the 50a is far small, and the desirable portion of lens 50a (crystal 50a) is used. Similarly, the field near the circumference of lens 50b (crystal 50b) is not used, but the optimal combination is attained from port 16a by port 16c and port 16b to port 16c. In order to attain the optimal connection here, 1 is the double precision of the distance d1 from a port to the nearest lens 2d of distance between two lenses (or the distance d1 from a port to the nearest lens is the distance of the double precision between two lenses).
[0037] Although the lens is illustrated so that it may have the end face which intersects perpendicularly with the shaft of a lens, a lens is polished in order to reduce the influence of the back reflection which is not desirable, and it is made to incline on it in fact in the illustrated example of an operation gestalt.
[0038] Subsequently, reference of drawing 15 shows the optical attenuator/switch of the first GRIN lens 51 relevant to

the input fiber 57, the second GRIN lens 55 relevant to an output fiber, the first wedge-action-die birefringence polariscope 52, a liquid crystal cell 50, and the advanced technology that reaches and has the second wedge-action-die birefringence polariscope 54. Although the ferrule holding fibers 57 and 58 is not shown here, it is shown by drawing 16 as 57 and 58. Corresponding to a control signal, a liquid crystal cell 50 rotates possible [control of the lightwave signal from the first GRIN lens 51]. As a result of a liquid crystal cell 50, depending on a state, a lightwave signal is transmitted or is not transmitted to the output fiber 58. Of course, signal intensity can be adjusted so that equipment may operate as an attenuator.

[0039] Drawing 16 illustrates the direction of the polariscopes 52 and 54 of drawing 15 , and various kinds of opticals axis of a liquid crystal cell 50. The optical axis of the first polariscope 52 is arranged in the arbitrary directions perpendicular to the advance line of the collimation lightwave signal from the first GRIN lens 51. 90 degrees rotates from the optical axis of the first polariscope 52, and the optical axis of the second polariscope 54 is arranged so that at right angles to the advance line of a collimation lightwave signal. When a cell 50 operates, the optical axis of liquid crystal becomes 45 degrees from the optical axis of the first polariscope 52, and a cell 50 has the thickness which has the phase delay which is 180 degrees of a lightwave signal, when light advances through the cell 50 concerned.

[0040] Operation of this drawing 15 , and the switch/attenuator of the advanced technology of drawing 16 is shown in drawing 17 , and a cell 50 operates there so that the liquid crystal in a cell 50 may be arranged. Another side is divided [an incident beam 60] into two polarization modes by one side as an ordinary ray as an extraordinary ray in the first polariscope 52. 90 degrees of lightwave signals rotate by the liquid crystal cell 50 which operated. In other words, an extraordinary ray polarizes in accordance with the unusual shaft of a polariscope 52.

[0041] As discussed for the background of invention, this advanced-technology composition has many faults, and, as a result, the cost of equipment is increasing. These are the demands to the thickness of the crystal to two crystals in a collimation beam spreading through these crystals.

[0042] If drawing 5 is referred to, other examples of an operation gestalt with a desirable this invention are shown, and the lens 105 is placed between the polarization rotator 132 and the small birefringence crystal 130 here. In order that the polarization state of the light spread through it may change the electric field of for example, the rotator 132 neighborhood, the thing of what form like the Faraday-rotation child who can make adjustable [of the control] possible is sufficient as the polarization rotator 132 by changing voltage or current.

[0043] Or a lithium-niobium crystal is used by the controllable electric field applied in order to change a refractive index, and it is used, as the phase of the light which it spreads through there is changed or liquid crystal described above. The refraction element of the form of the mirror 136 placed since it was refracted behind output port 110b is near the polarization rotator 132 about the collimation incident light on which it was projected by input port 110a.

[0044] If the polarization state of the light spread through a polarization rotator does not change, all the light on which it was projected by input port 110a is essentially combined with output port 110b. Since a polarization state is changed by giving the suitable control signal for the rotator 132 turning around the light spread through there, a reflective beam is partially accepted to output port 110b, and is combined with it. By controlling correctly the amount of the rotation given by the rotator 132, the grade of attenuation is controlled correctly. For the optimal combination, it is desirable that the distance d from a port to the input/focal plane of a lens 105 is equal to the distance d from the collimation end face of an output/lens to a mirror 136.

[0045] The example of an operation gestalt of this invention shown in drawing 8 from drawing 6 equips the input/output port, and the input edge of the equipment during a crystal with the lens. Although these examples of an operation gestalt are not so desirable as the example of an operation gestalt shown in drawing 5 , since only one crystal is required, they just offer a remarkable advantage to the attenuator of the advanced technology. Offering two big adjustment crystals increases the cost of an optical attenuator substantially.

[0046] Reference of drawing 6 shows the attenuator which carries out the collimation and which has input port 110a and output port 110b in about 105 quarter pitch GRIN lens substantially, respectively. A collimation beam is received next to a lens 105, and there is a birefringence crystal 140 which was able to decide the size to divide a beam into two polarization beams which intersect perpendicularly. The rotator 132 and the refraction element 146 of the form of a partial transparency refractor which have been arranged so that the light from a crystal may be received are arranged in order to turn to output port 110b the input beam on which it was projected by port 110a and to draw it back substantially. It is placed in order that the monitor of the form of a detector 141 may detect the small portion of the light revealed through a partial transparency refractor. In order to divide an input beam into two beams by [advantageous] offering this clinch composition especially, and in order to combine two beams with the beam of a piece at opposite direction, the crystal of a piece is merely required.

[0047] Two drawing 7 shows the same example of an operation gestalt used instead of the small GRIN lenses 105a and 105b being single big GRIN lenses. Near the quarter pitch GRIN lenses 105a and 105b, the attenuator with input port

111a and output port 111b which carries out the collimation is shown substantially. There is a birefringence crystal 140 which was able to decide the size to receive the collimation beam from lens 105a, and to divide a beam into two polarization beams which intersect perpendicularly near the lenses 105a and 105b. It is placed in order that a rotator (polarization rotator) 132 may receive the light from a crystal.

[0048] And the reflective means of the form of a cube corner reflector 146 is near the rotator, the input beam on which it was projected by port 111a is turned to output port 111b, and it leads back substantially. In order to divide an input beam into two beams and to combine two beams with the beam of a piece by [advantageous] offering this clinch composition especially at opposite direction, the crystal of the free piece used for ** on the other hand is required.

[0049] Although the example of an operation gestalt shown in drawing 8 is similar in the example of an operation gestalt of drawing 7 , and many respects, it is used instead of a mirror 148 being a cube corner reflector. In order that the light on which it was projected at the edge of input lens 105a may ensure arranging optically with output lens 105b, it is projected on light in the port of the input lens end face offset from the optical axis of lens 105a.

[0050] Of course, it thinks, without many examples of a gestalt of other operations deviating from the intention and range of this invention.

[0051]

[Effect of the Invention] According to this invention, it is projected on light at the edge of equipment (optical attenuator), and it is received at the same edge of equipment. The refractor of a reflective means using the mirror, the reflector, and a refraction element (reflective element) like a cube corner reflector can be used in order to offer clinch composition. Before the collimation of the non-collimation light beam is carried out, the further advantage may be realized by offering the composition on which it is projected by the comparatively thin small crystal.

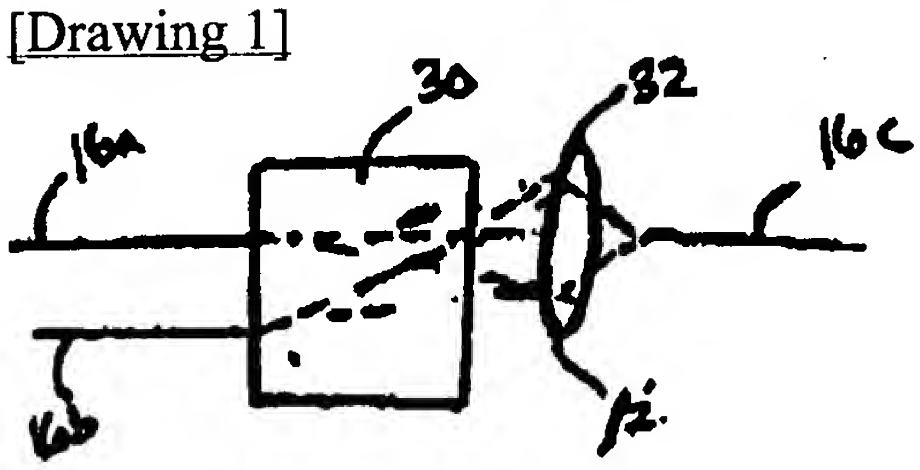
[0052] The advantages of the structure by this invention are a large number. A fewer smaller component is needed, therefore equipment is quite cheap although manufactured. Furthermore, equipment is smaller than the equipment of the conventional technology of performing polarization combination or a split.

[Translation done.]

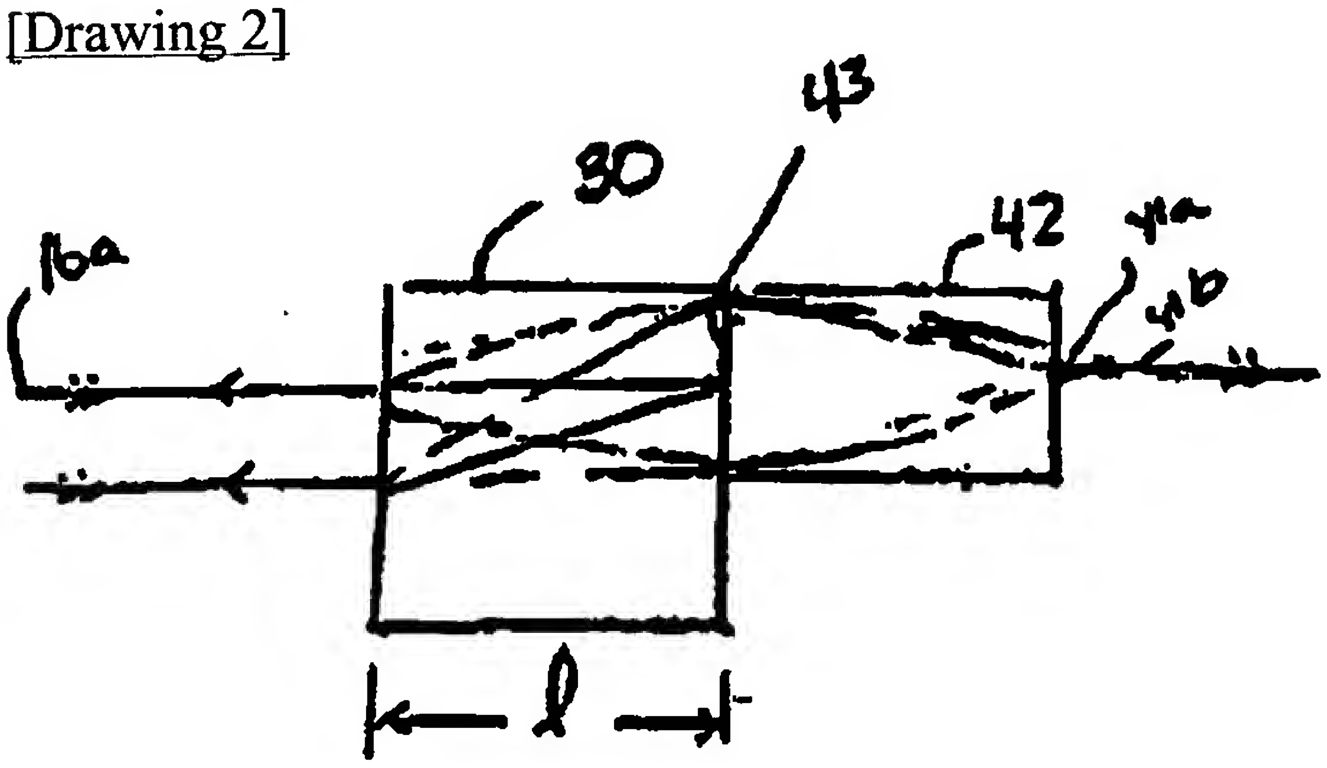
* NOTICES *

DRAWINGS

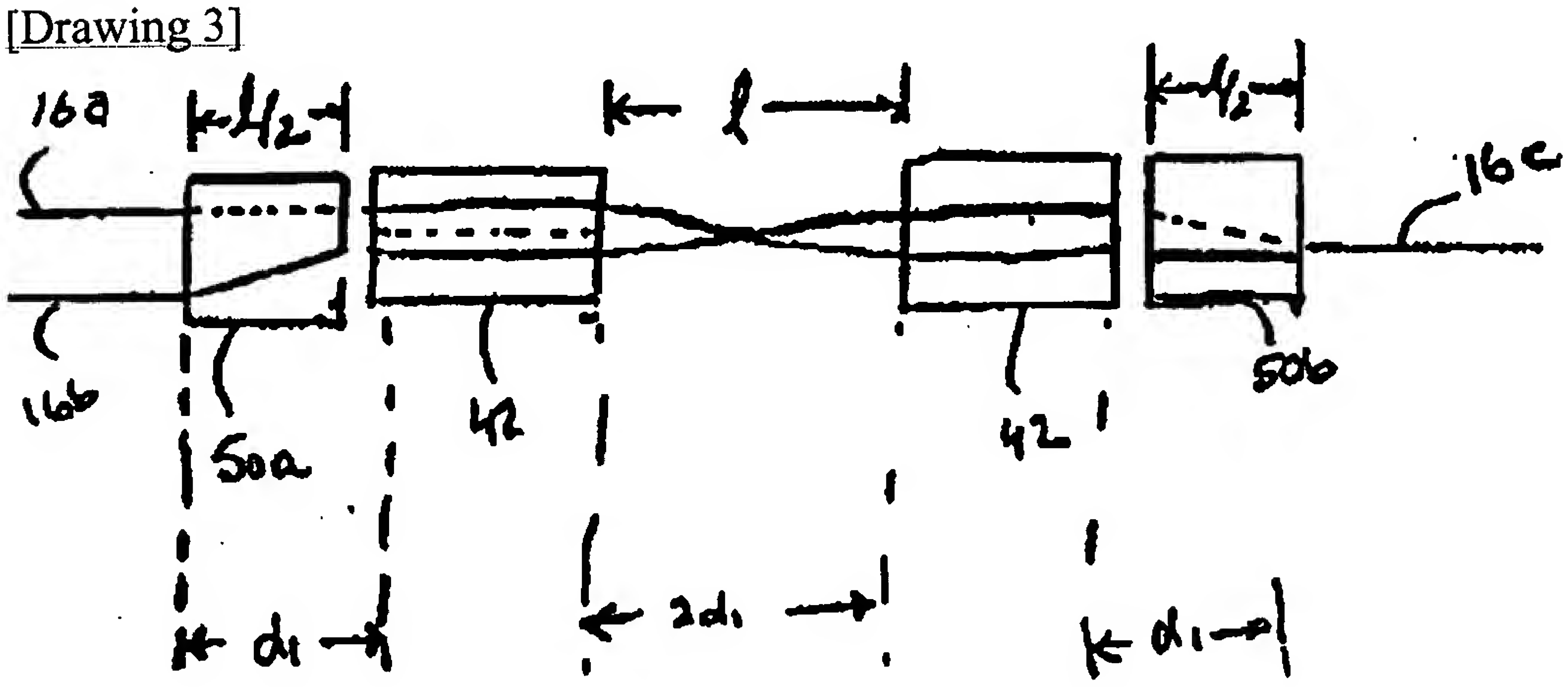
[Drawing 1]



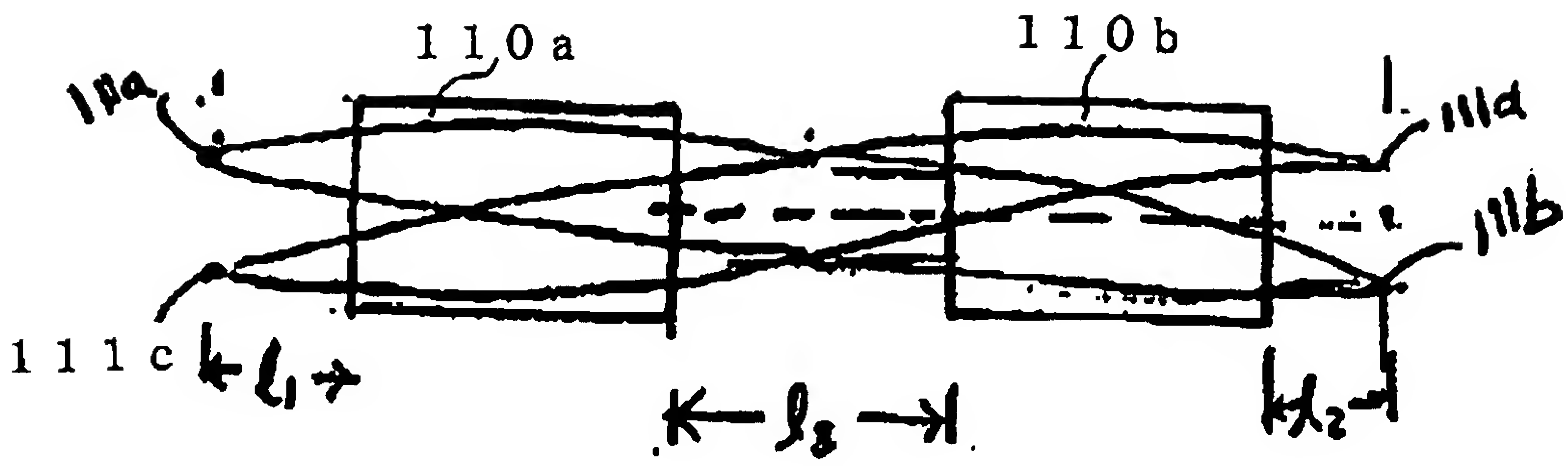
[Drawing 2]



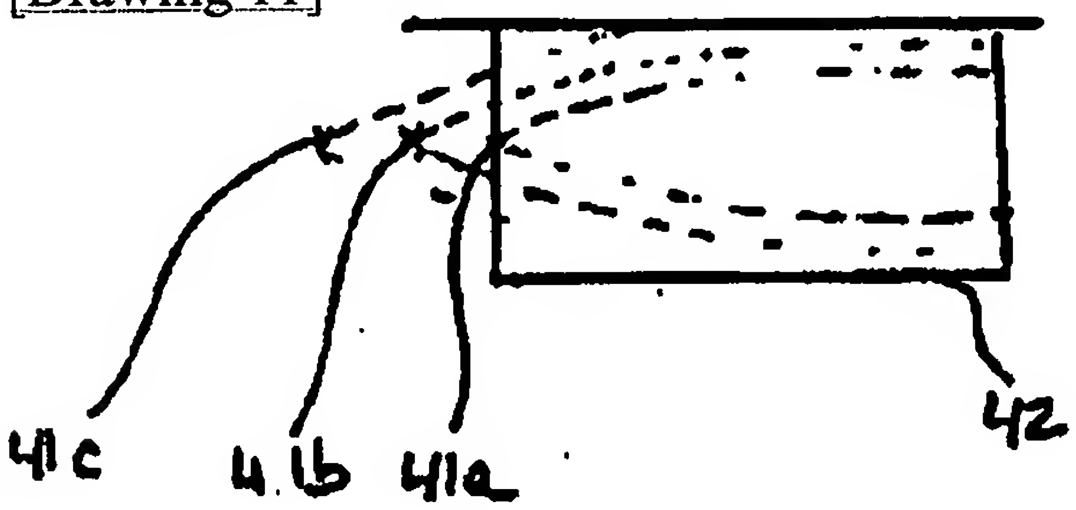
[Drawing 3]



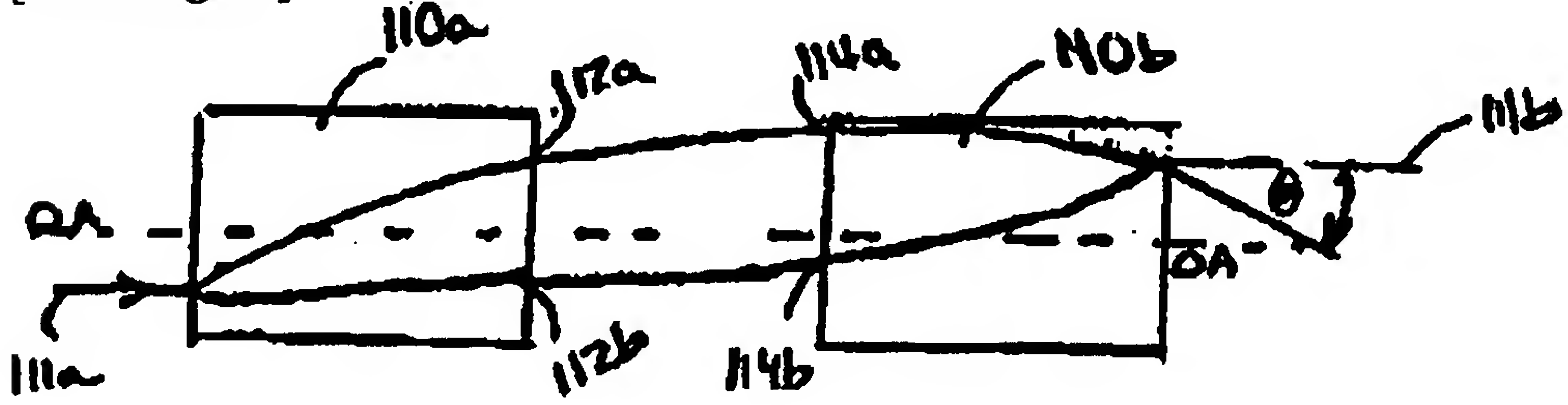
[Drawing 4]



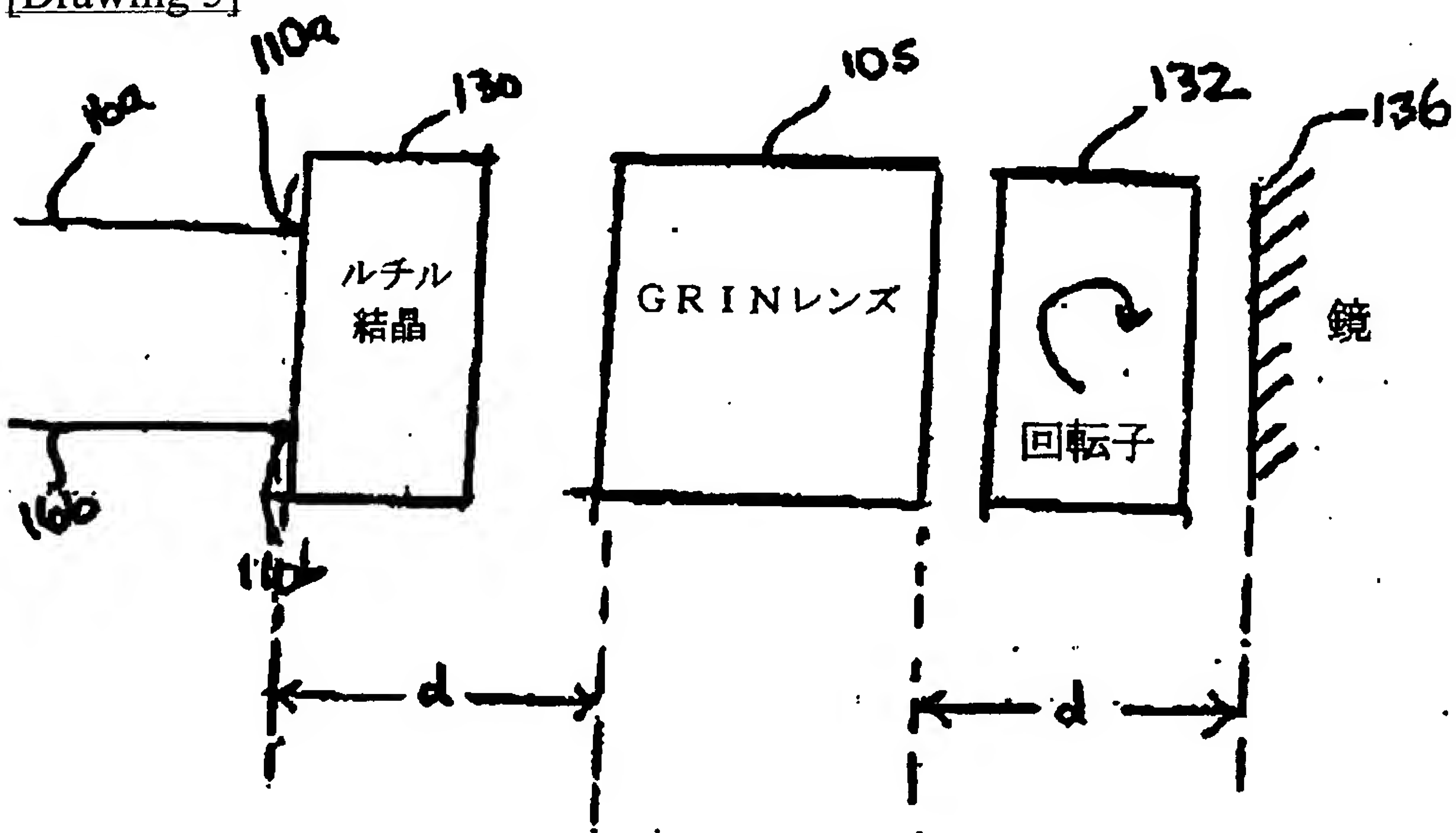
[Drawing 11]



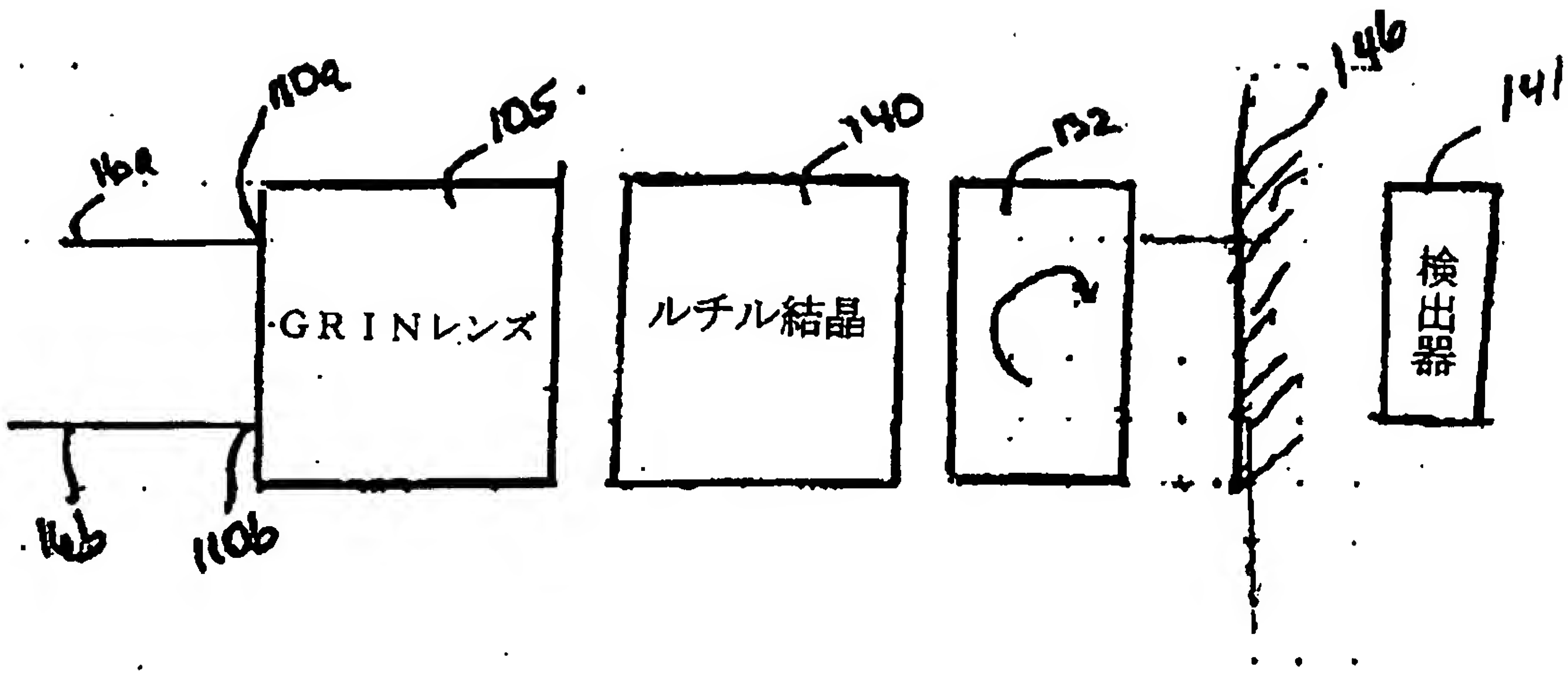
[Drawing 13]



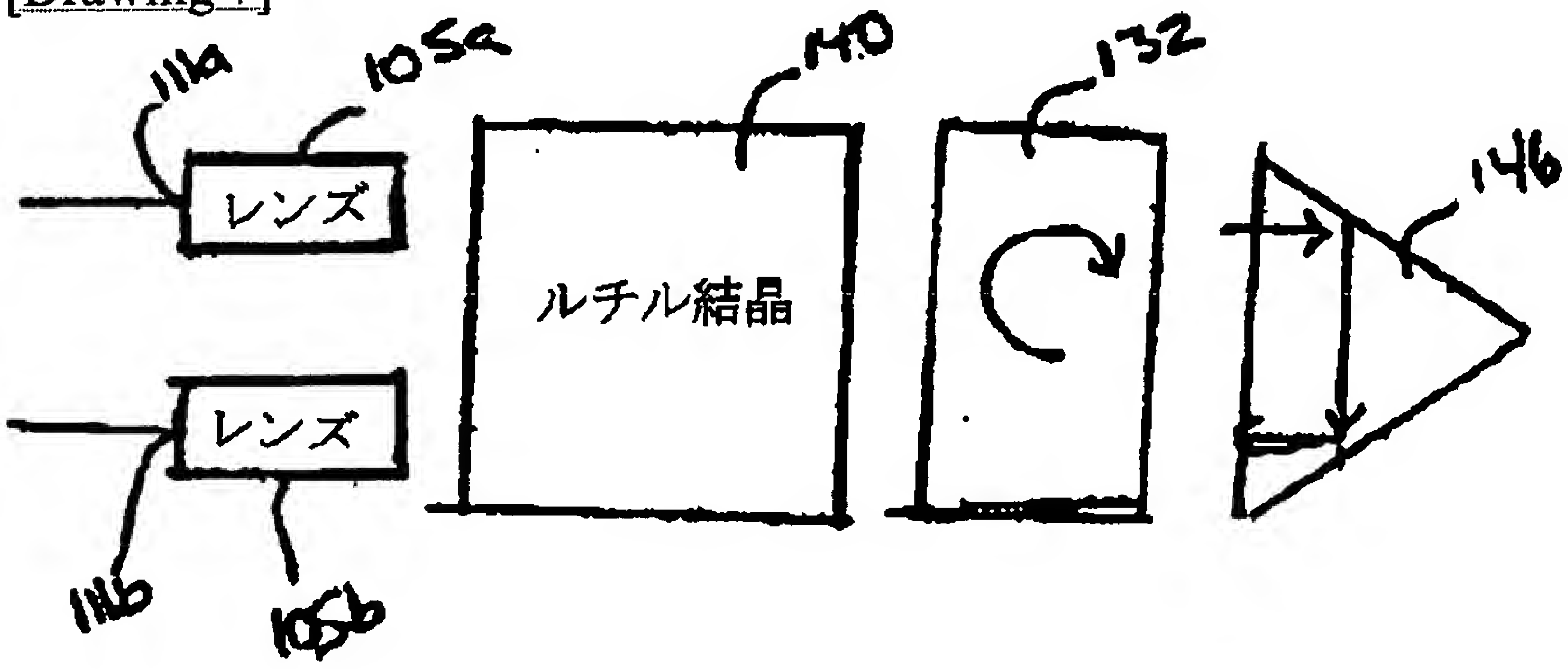
[Drawing 5]



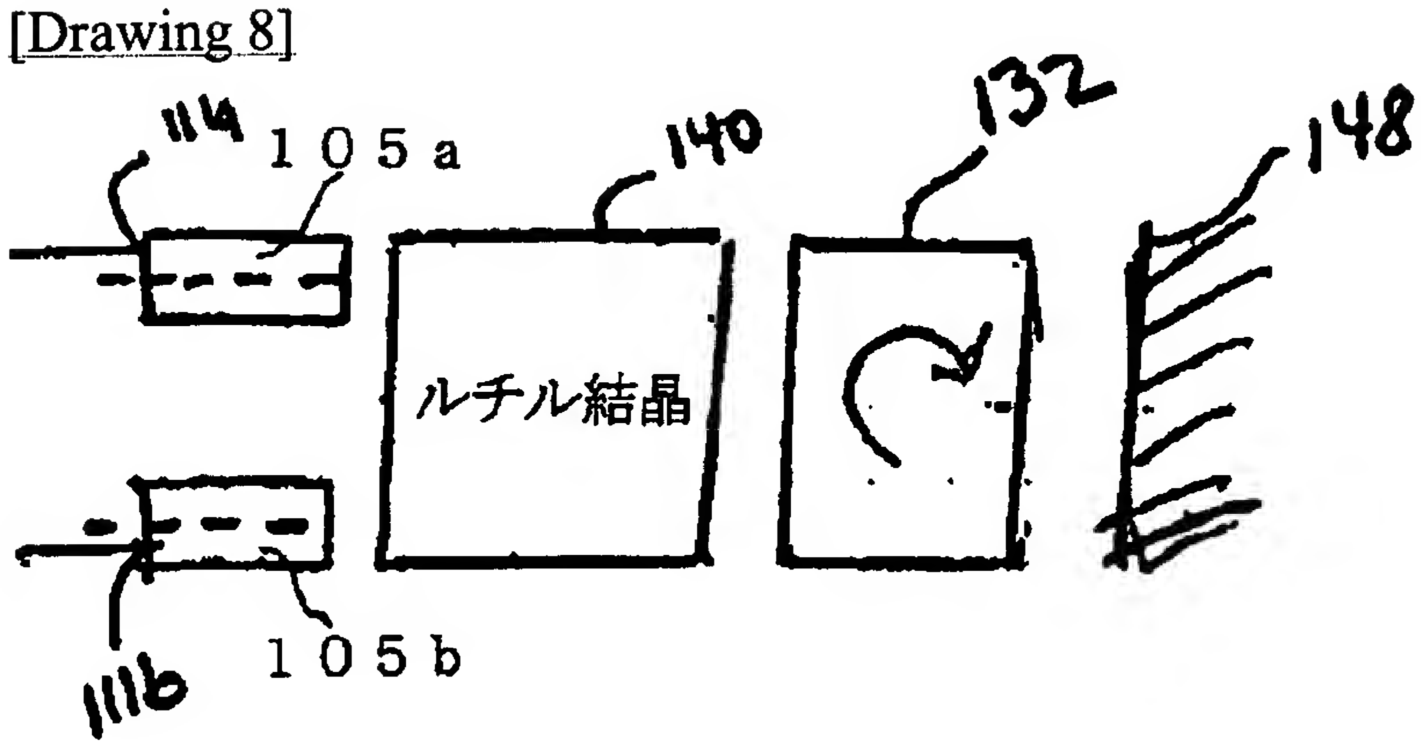
[Drawing 6]



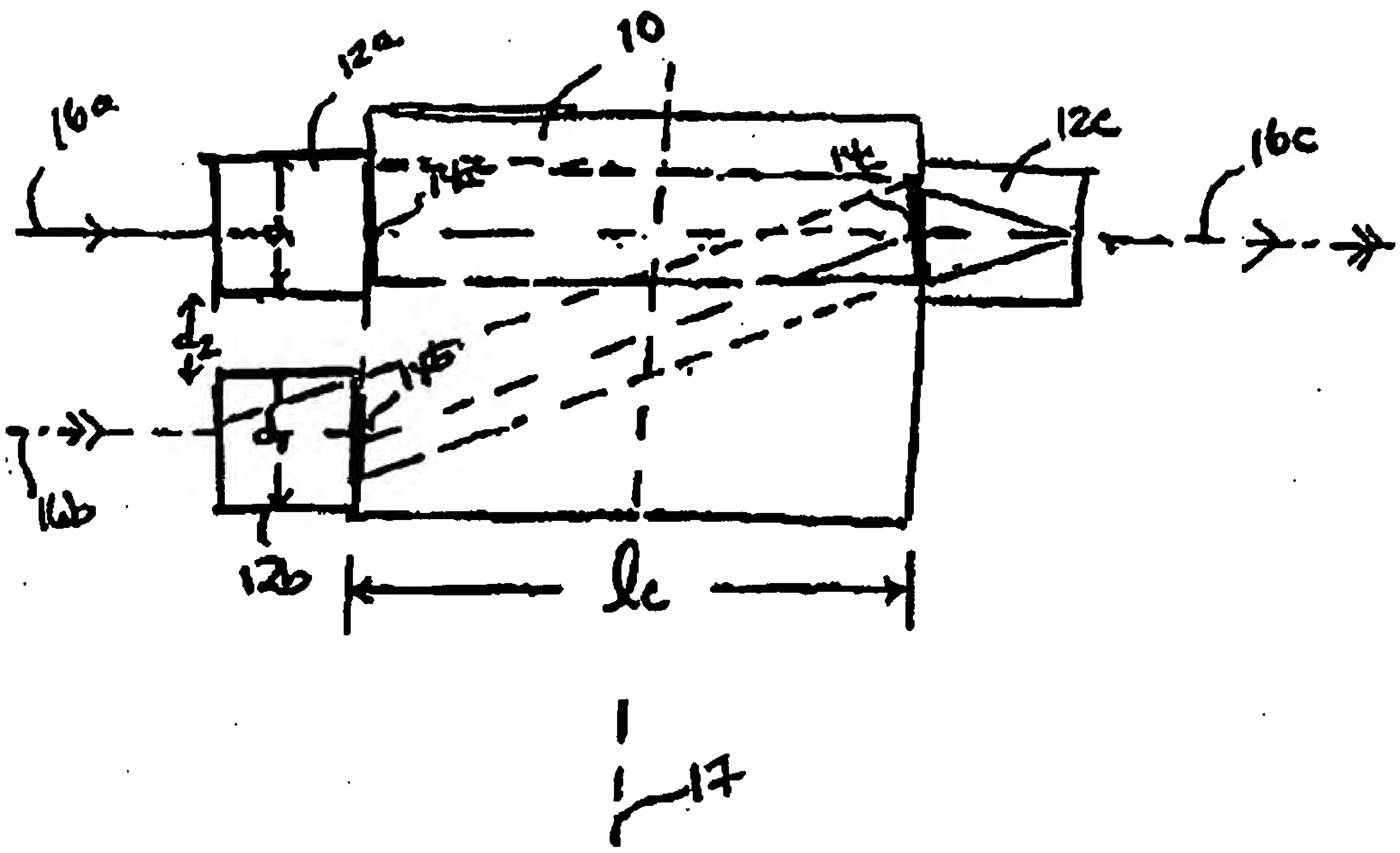
[Drawing 7]



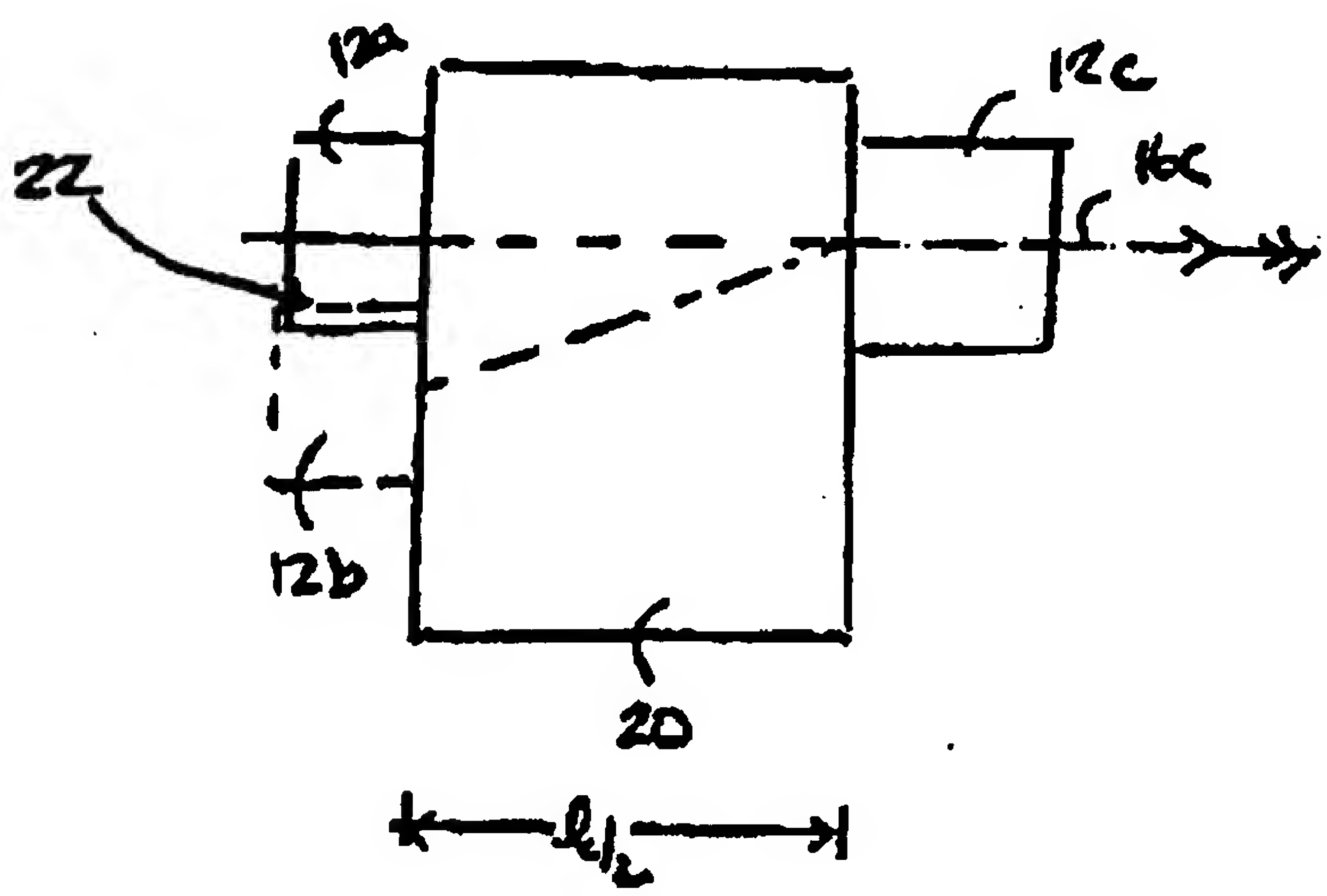
[Drawing 8]



[Drawing 9]

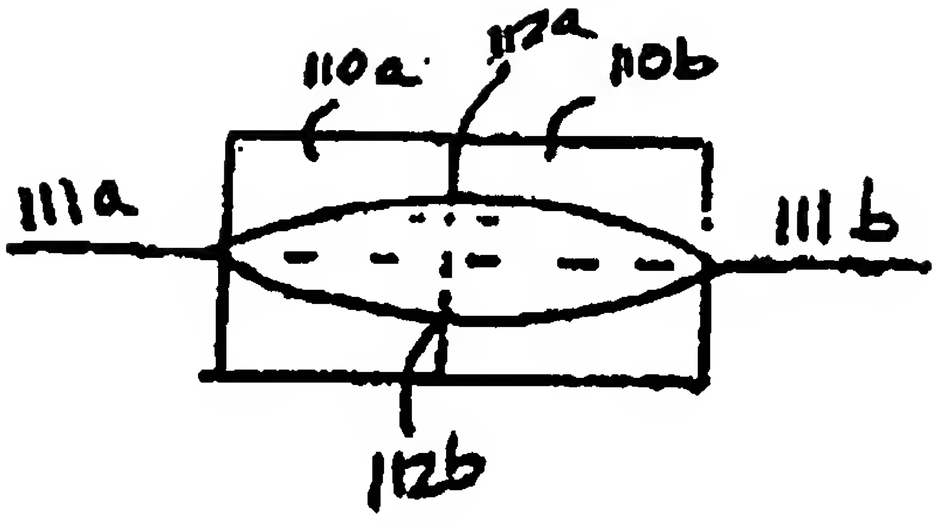


[Drawing 10]

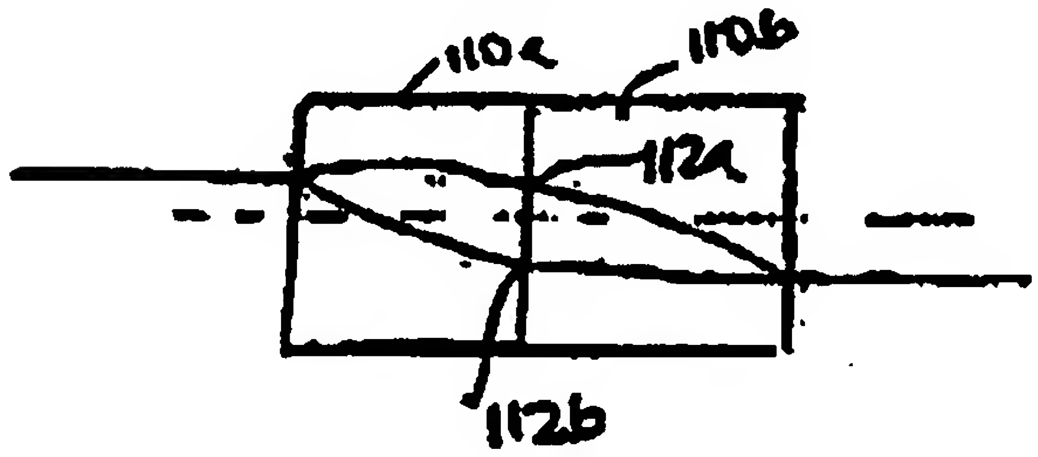


[Drawing 12]

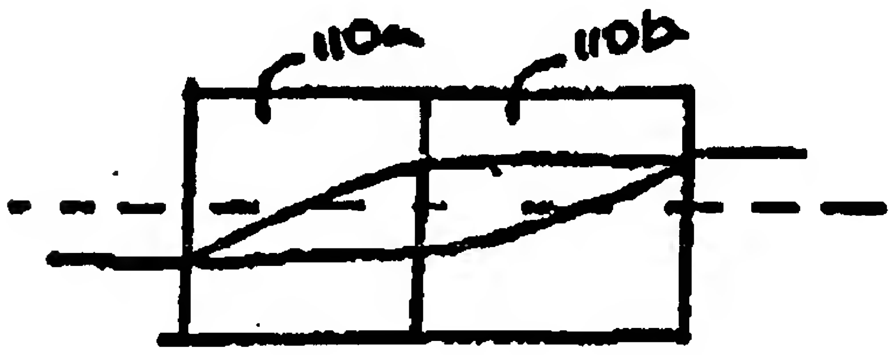
(a)



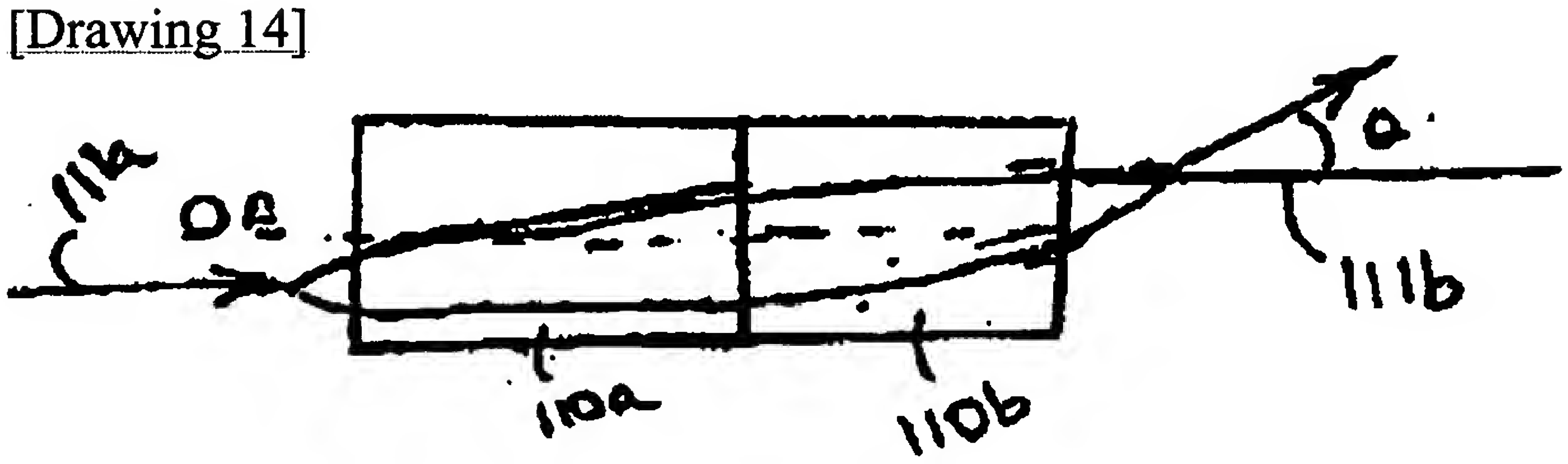
(b)



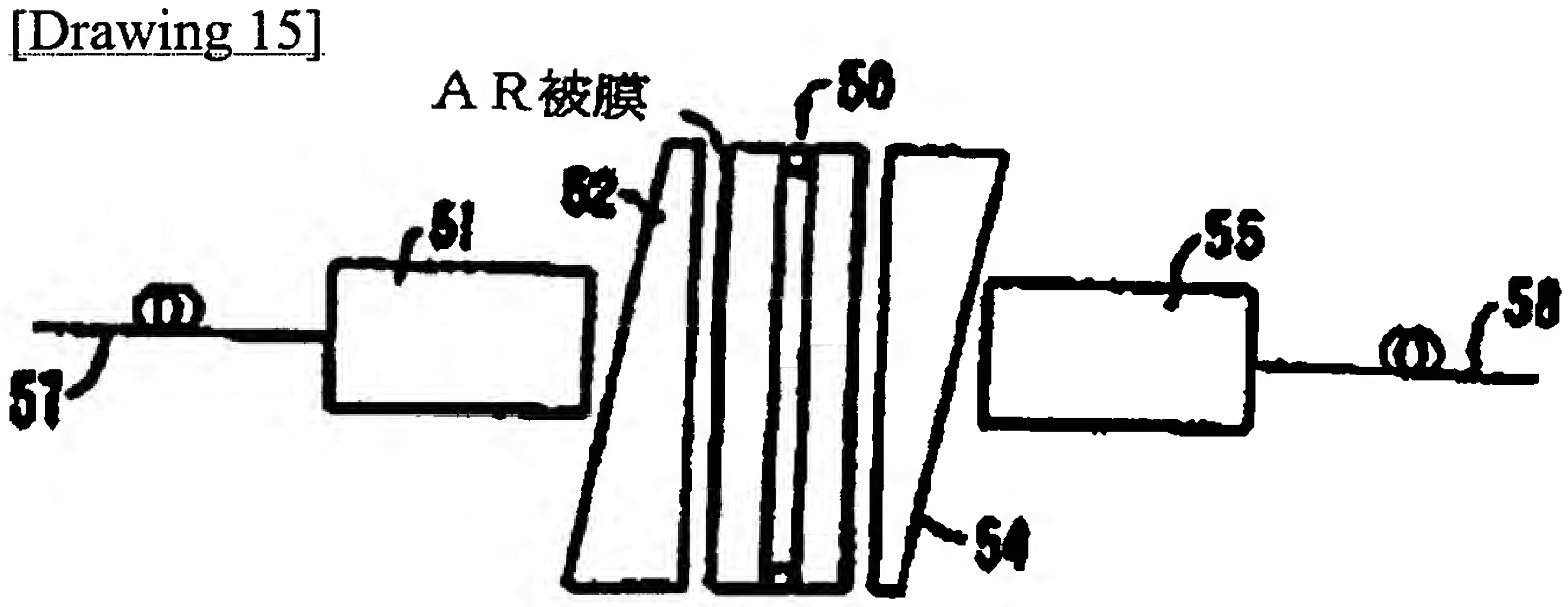
(c)



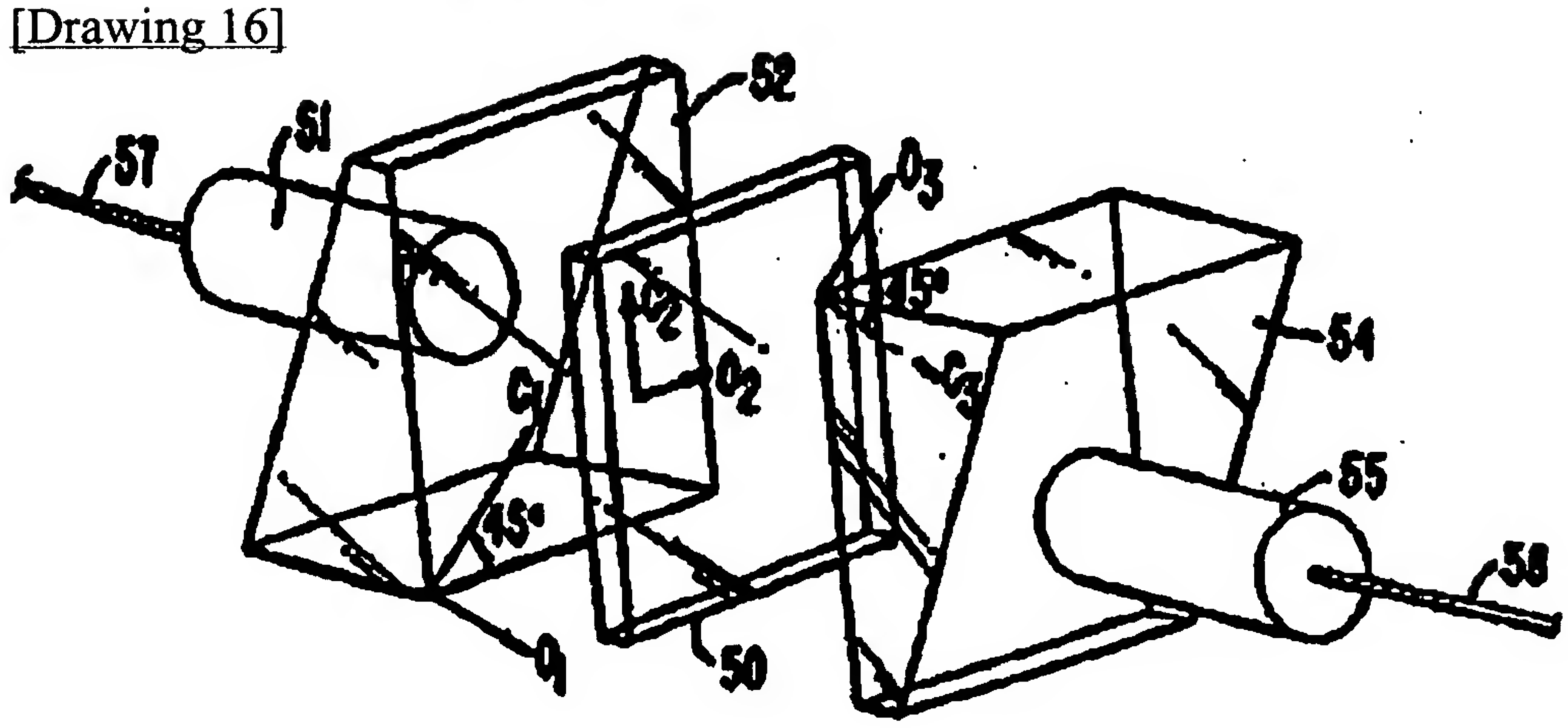
[Drawing 14]



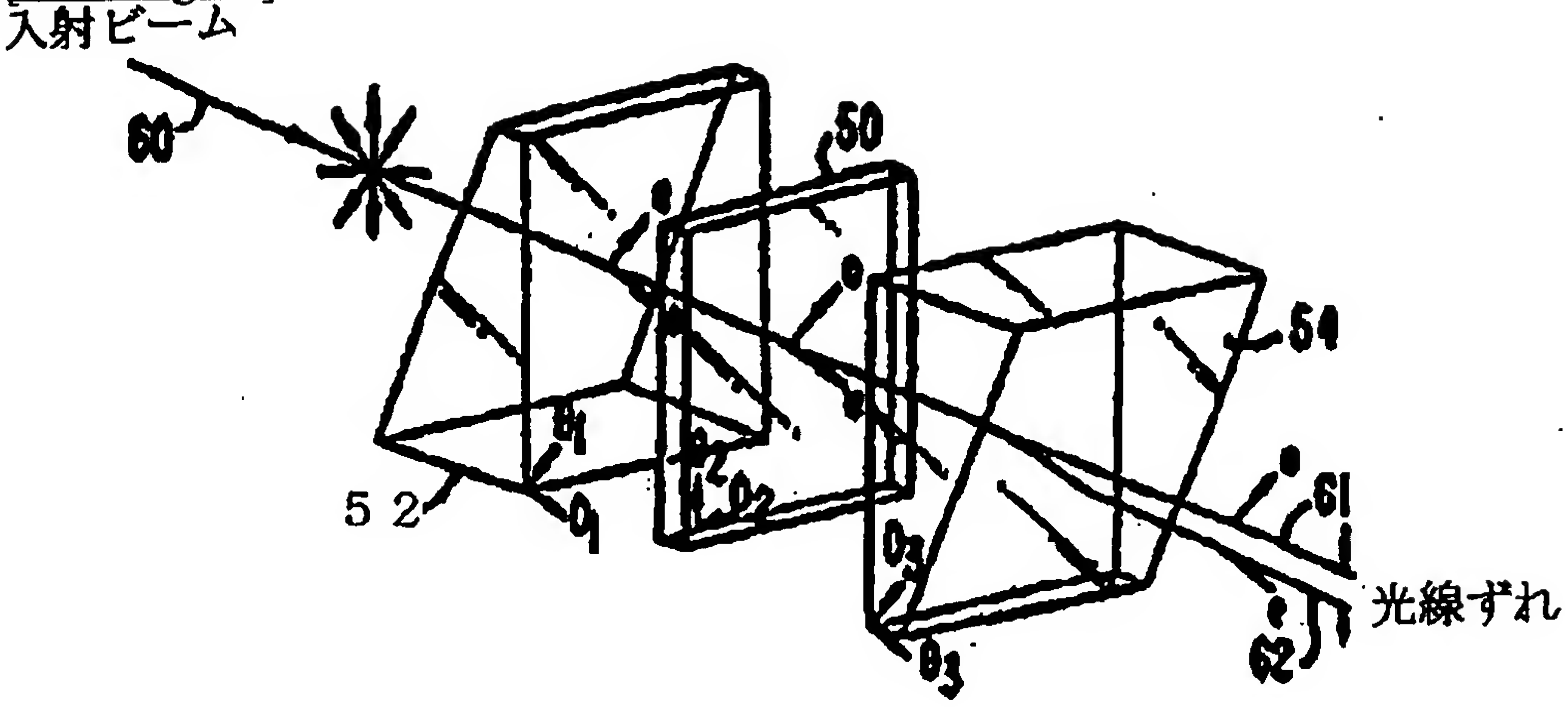
[Drawing 15]



[Drawing 16]



[Drawing 17]



[Translation done.]